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General Certificate of Education  
 June 2004  
 Advanced Subsidiary Examination



**SCIENCE FOR PUBLIC UNDERSTANDING**  
**Unit 1 Issues in the Life Sciences**

**SPU1**

Monday 14 June 2004 Morning Session

**No additional materials are required.**  
 You may use a calculator.

Time allowed: 1 hour 15 minutes

**Instructions**

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.
- Show your working in **all** calculations.

**Information**

- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.
- In your answer to Question 4(c) you will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate. The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
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Total (Column 1)	→		
Total (Column 2)	→		
TOTAL			
Examiner's Initials			

1 Some diseases can suddenly infect large numbers of people in a short time causing an epidemic. Influenza, often known as “flu”, is a viral disease that can cause epidemics. Epidemics can also be caused by bacterial diseases such as cholera, which is spread by contaminated water and sewage.

(a) The world-wide influenza epidemic in 1918-19 at the end of World War I infected about 28% of the world’s population. Between 20 and 40 million people died. In an attempt to prevent the spread of the disease at that time the authorities:

- isolated people who were infected;
- closed schools and theatres and banned public meetings;
- gave advice on regular hand-washing.

(i) Choose **two** of these measures and explain why they were thought necessary, using the germ theory of disease.

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(2 marks)

(ii) Suggest **two** other measures that might have been taken to control the spread of a cholera epidemic.

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(2 marks)

(iii) When the new viral disease, SARS, appeared in 2002 it was found to spread rapidly and was thought to have a high death rate. Some governments reacted by banning travel to and from infected countries, making health checks compulsory and isolating known cases and their contacts.

In your view were governments justified in restricting people's freedoms in these ways in 2002? Give your reasons.

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(2 marks)

- (b) (i) After recovering from an infectious disease the patient is normally unlikely to get the same disease again for some months or years. Explain why.

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(2 marks)

- (ii) There are regular influenza epidemics because the virus mutates, creating slightly different strains. Each epidemic is caused by a different strain of the virus.

Explain how this frequent mutation gives the influenza virus an evolutionary advantage.

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(2 marks)

10

2 Some non-infectious diseases are caused by genes, some by environmental factors, including lifestyle, and many others by an interaction between genetic and environmental factors.

- (a) Diabetes is a serious disease which increases the risk of other conditions, such as heart disease and blindness, if not very carefully managed.

- (i) Diabetes is known to run in families over several generations. Explain whether this suggests a genetic cause or an environmental/lifestyle cause.

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(1 mark)

- (ii) Within some populations the incidence of diabetes has increased up to three-fold over the last 30 years. Do you think that this increase suggests a genetic change in the population or a change in the environment or lifestyle? Explain your answer.

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(2 marks)

Turn over ►

- (iii) **Figure 1** shows the chance of developing three different diseases if an identical twin already has the disease. Identical twins both have exactly the same genetic make-up.

disease	chance of developing the disease if identical twin has the disease
cystic fibrosis	100%
type 1 diabetes (onset in childhood)	30 - 50%
type 2 diabetes (onset as adults usually over 40)	70 - 80%

**Figure 1**

For which of the three diseases shown in **Figure 1** is the environment/lifestyle likely to be the most significant causative factor? Explain your answer.

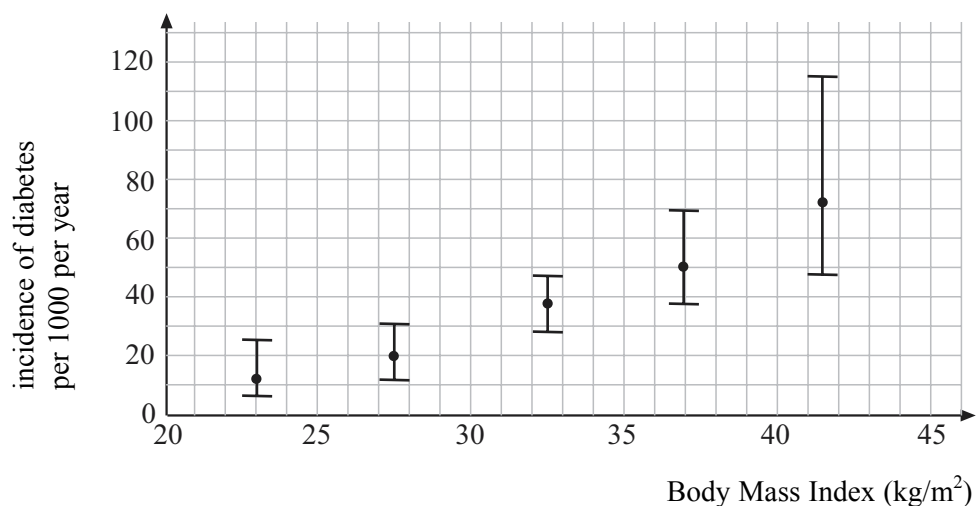
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(2 marks)

- (b) Type 2 diabetes develops later in life. Epidemiological studies, where a group of people are followed over several years, are used to identify risk factors. **Figure 2** shows the relationship between obesity and diabetes found in a study of 3137 people. Body Mass Index (BMI) is a widely used indicator of obesity.



**Figure 2**

(i) What relationship between BMI and diabetes is suggested by **Figure 2**?

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(2 marks)

(ii) Use **Figure 2** to estimate the increase in risk of diabetes caused by a BMI of 37 kg/m<sup>2</sup> relative to a BMI of 23 kg/m<sup>2</sup>. Show your working.

(2 marks)

(iii) The uncertainty in the data in **Figure 2** is indicated by the length of the vertical bars. Does the uncertainty in the incidence of diabetes at high BMI values raise doubts about the relationship between BMI and diabetes? Explain your answer.

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(2 marks)

(c) (i) Name **one** other disease for which obesity is also a significant risk factor.

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(1 mark)

(ii) There is evidence that the incidence of obesity is increasing amongst young people in the UK and some are even developing type 2 diabetes at a young age. Suggest **two** preventive measures you think would be realistic and effective in reversing this trend.

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(2 marks)

3 In China traditional medicine uses a very different approach to health from that used by modern "scientific" medicine. A wide range of traditional remedies has been used against fevers, including malaria, for at least 2000 years. These remedies include acupuncture and over 200 different plants.

(a) Most of these remedies are now known to be ineffective as cures for malaria. Suggest some reasons why they were widely used for so long.

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(2 marks)

(b) In 1967 scientists in China started systematically testing these traditional plant remedies in an attempt to find a cure for malaria. Most had absolutely no effect but one, sweet wormwood, shown in **Figure 3**, was found to be very effective. The Chinese extracted the active drug, Artemisinin, and tested it in vitro, in animals and then in patients.



**Figure 3**

In the 1980s Western doctors learned about Artemisinin and its success in treating malaria that had become resistant to other widely used drugs. However some were reluctant to allow its use until they had also tested it for themselves using randomised controlled clinical trials.

(i) What is a controlled trial?

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(2 marks)

(ii) Explain what *randomised* means in the design of drug trials.

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(1 mark)

(iii) Explain why randomisation is necessary.

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(2 marks)

(c) The combined results of some of these trials on seriously ill patients are shown in **Figure 4**. In these trials Artemisinin was compared with quinine, one of the standard treatments for malaria.

**Deaths from malaria after treatment with Artemisinin or quinine**

type of malaria	deaths after treatment with Artemisinin (percentage)	total number of patients treated with Artemisinin	deaths after treatment with quinine (percentage)	total number of patients treated with quinine
all forms of malaria	15%	915	18%	904
cerebral malaria	19%	437	19%	432
mixed malaria	11%	478	17%	472

**Figure 4**

(i) State **two** conclusions you might draw from these results.

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(2 marks)

(ii) Explain why the Artemisinin was compared with quinine and not with a placebo.

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(2 marks)

Turn over ►

(ii) About 20 years after the drug was first used in China, Western regulators considered they had sufficient evidence from their own trials to approve Artemisinin for use by their doctors. Many people must have died of drug-resistant malaria because of this delay. Do you think the delay was justified? Explain your answer.

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*(2 marks)*



**TURN OVER FOR THE NEXT QUESTION**

**Turn over ▶**

- 4 In the last few years there have been major advances in our understanding of human genes from the Human Genome Project and other research. However, despite the hopes raised there have been few direct health benefits so far and more research is needed. Animal testing is used to learn the function of genes and to test therapies. This often involves genetically manipulated animals.

**The number of experimental procedures on animals in the UK from 1995 to 2002**

	1995	1999	2001	2002
total number of animal procedures	2 700 000	2 650 000	2 620 000	2 730 000
total number of procedures involving genetically manipulated animals	220 000	500 000	630 000	710 000

**Figure 5**

- (a) (i) Describe the trends in the use of animals from 1995 - 2002, as shown in **Figure 5**.

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*(2 marks)*

- (ii) Suggest reasons for the trends.

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*(2 marks)*

- (b) Cystic Fibrosis is a human genetic disease caused by a defect in the CF gene. It affects the lungs and digestive system. Despite intensive modern treatments, patients have an average life expectancy of about 30 years. One potential treatment for cystic fibrosis is gene therapy in the lung cells.

Outline the key steps involved in gene therapy using any genetic disease as an example.

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*(3 marks)*

- (c) In order to improve gene therapy the techniques must be tested on animals. Mice can be genetically manipulated to carry the same defect in the CF gene. These mice are used to test new therapies.

You will be awarded up to 4 additional marks for the quality of written communication in your answers to parts (i), (ii) and (iii) of this question.

- (i) What ethical arguments might someone with cystic fibrosis use to support research on animals genetically manipulated to suffer from cystic fibrosis?

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*(2 marks)*

- (ii) What ethical arguments might an animal rights activist use to oppose research on animals genetically manipulated to suffer from cystic fibrosis?

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*(2 marks)*

- (iii) It seems likely that any significant health benefits from new genetic information will require genetic manipulation of large numbers of animals.  
Do you think this is justified? Explain the reasons for your answer.

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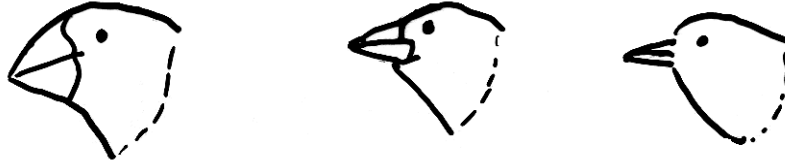
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*(2 marks)*

**Quality of written communication**  
*(4 marks)*

5 Darwin's observations on the Galapagos Islands, off the coast of South America, provided important evidence for his theory of the origin of species by natural selection. He studied a type of bird called a finch. On the Galapagos Islands there are 13 separate species of finch. The species differ mainly in beak size, each beak being well suited to the type of food the bird eats. Some examples are shown in **Figure 6**. Different species eat large seeds, small seeds, flowers or insects.



**Figure 6**

Modern research on the Galapagos finches has provided more evidence in support of the theory.

- (a) When their DNA was studied it was found that all 13 species seemed to be more closely related to a single finch species in South America than to any other bird. It is suggested that a few of these South American finches were accidentally blown onto the Islands at a time before there were other birds there.

Explain how the DNA evidence supports the idea that new species can arise by evolution.

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*(2 marks)*

- (b) The description below comes from a report on how a drought in the 1970s affected the population of the species of large-beaked finches.

‘During the drought, when big tough seeds were all a bird could find, these big-bodied, big-beaked birds had come through the best. The average beak before the drought was 10.68 mm long. The average beak of the large-beaked finches that survived the drought was 11.07 mm long. Variations too small to see with the naked eye had helped make the difference between life and death.’

Explain how the story of the large-beaked finches during the drought provides evidence for natural selection.

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*(2 marks)*

- (c) The theory of evolution by natural selection was first proposed in 1858 and has been widely accepted. Why do you think scientists continue to do research on evolution, using new techniques, such as the DNA analysis described in part(a)?

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*(2 marks)*

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**END OF QUESTIONS**

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